

AWS re:Invent

NOV. 27 – DEC. 1, 2023 | LAS VEGAS, NV

TNC215

Introduction to MLOps engineering on AWS

John Tuffin

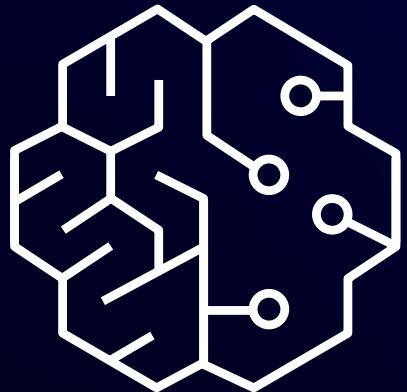
Principal Technical Instructor
Amazon Web Services



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ML for innovation and more

Machine learning (ML)

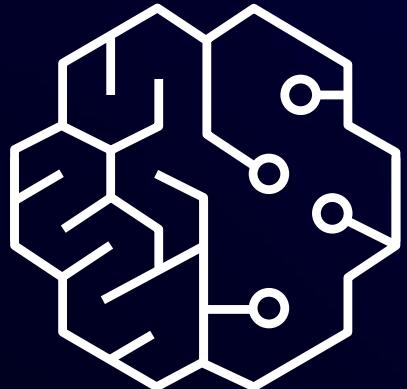


Innovation



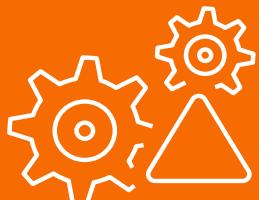
ML for innovation and more

Machine learning (ML)



Operational workflows for ML include the following:

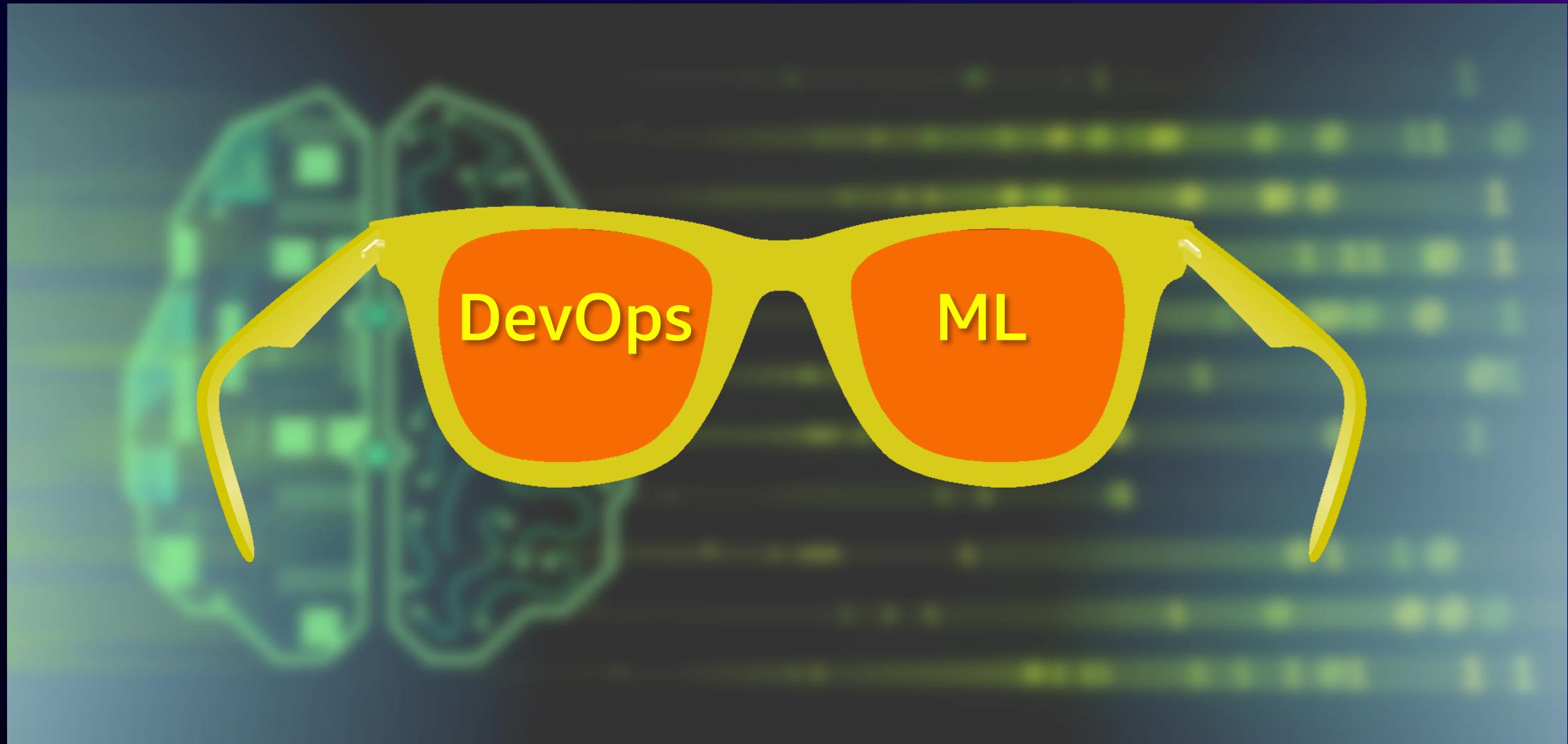
- Build
- Train
- Deploy
- Monitor
- Manage
- Re-train



Innovation



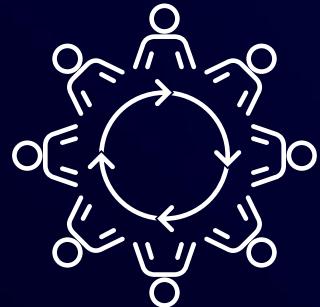
Operations perspective on ML



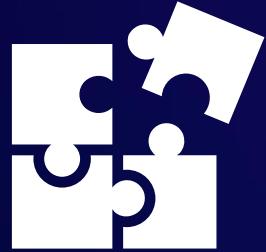
Operations perspective on ML



Considerations and challenges of MLOps



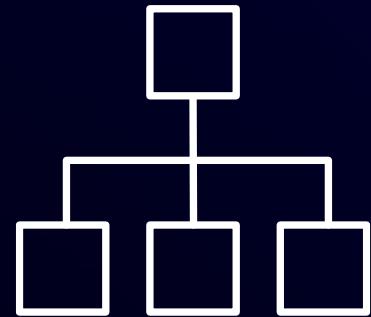
Culture



Lack of cross-functional teams



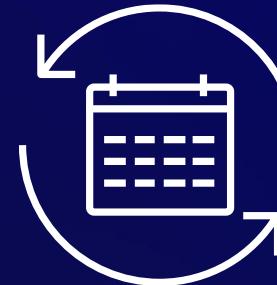
Priorities and needs (personas)



Organizational structure



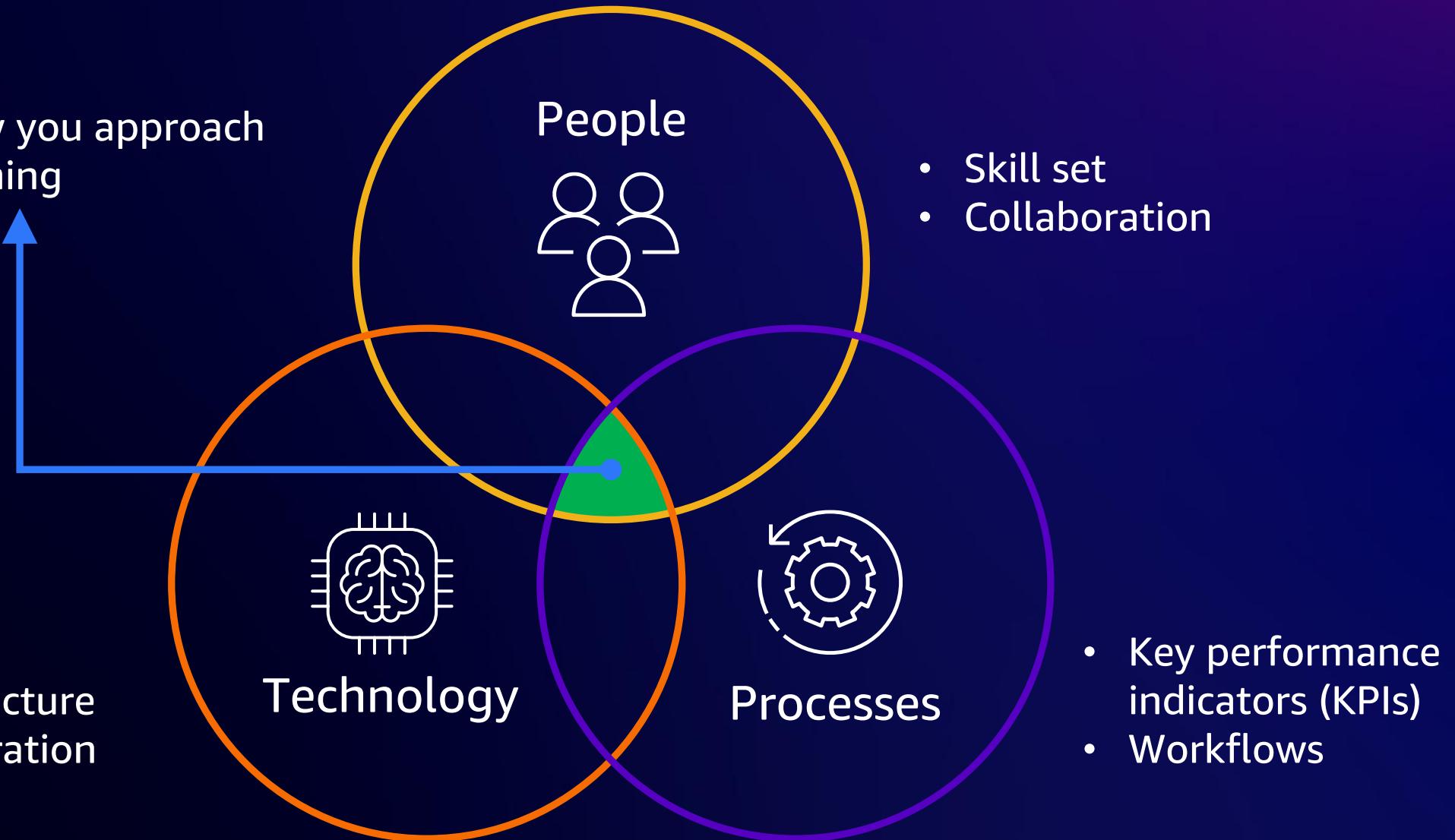
Skill set



Unique aspects of ML lifecycle

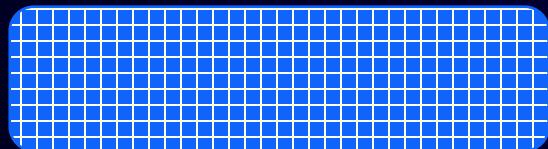
Machine learning operations (MLOps) approach

MLOps is how you approach machine learning

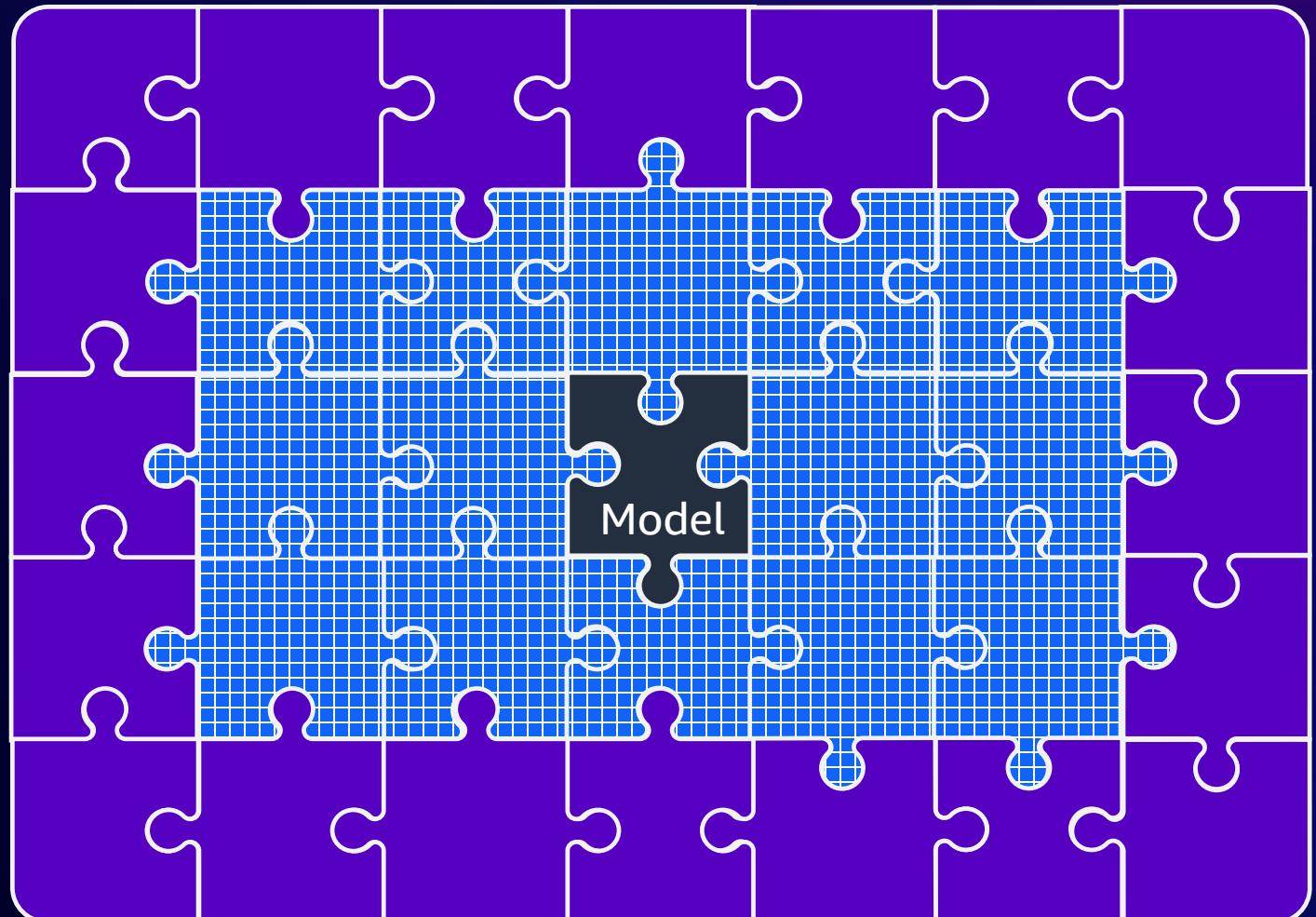


From pilot to production

Required tasks
and infrastructure for
Pilot



Production



Agenda

Processes



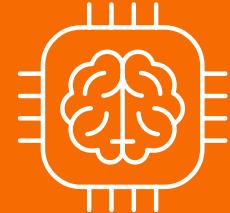
Describe the ML workflow and how it relates to MLOps

People



List the roles that need to collaborate for MLOps

Technology



Describe the importance of ML training and deployment pipelines

Security and governance



Define ML governance

ML maturity model

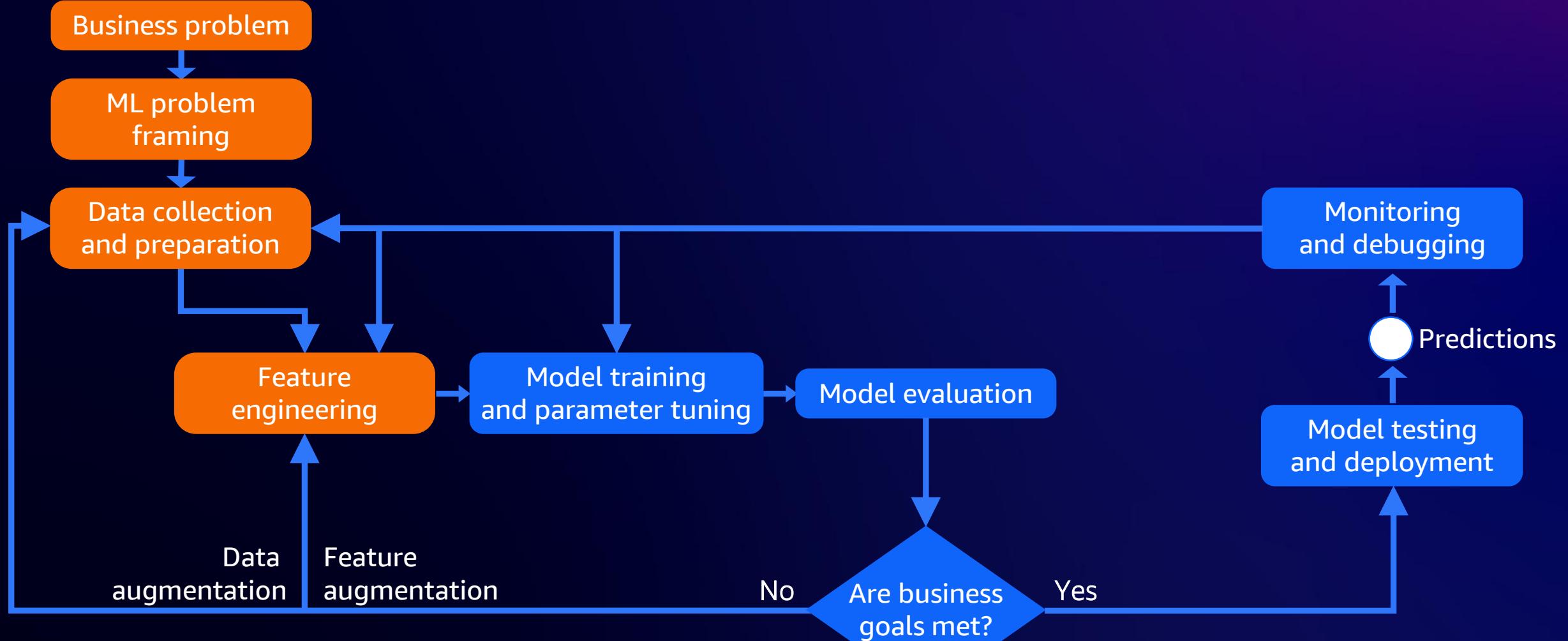


Describe the phases of the ML maturity model

Processes

- 
- Topic A: Processes
 - Topic B: People
 - Topic C: Technology
 - Topic D: Security and governance
 - Topic E: MLOps maturity model

Machine learning is an iterative process



MLOps and the ML workflow

Data preparation

Model build

Model evaluation

Model selection

Deployment

Monitoring

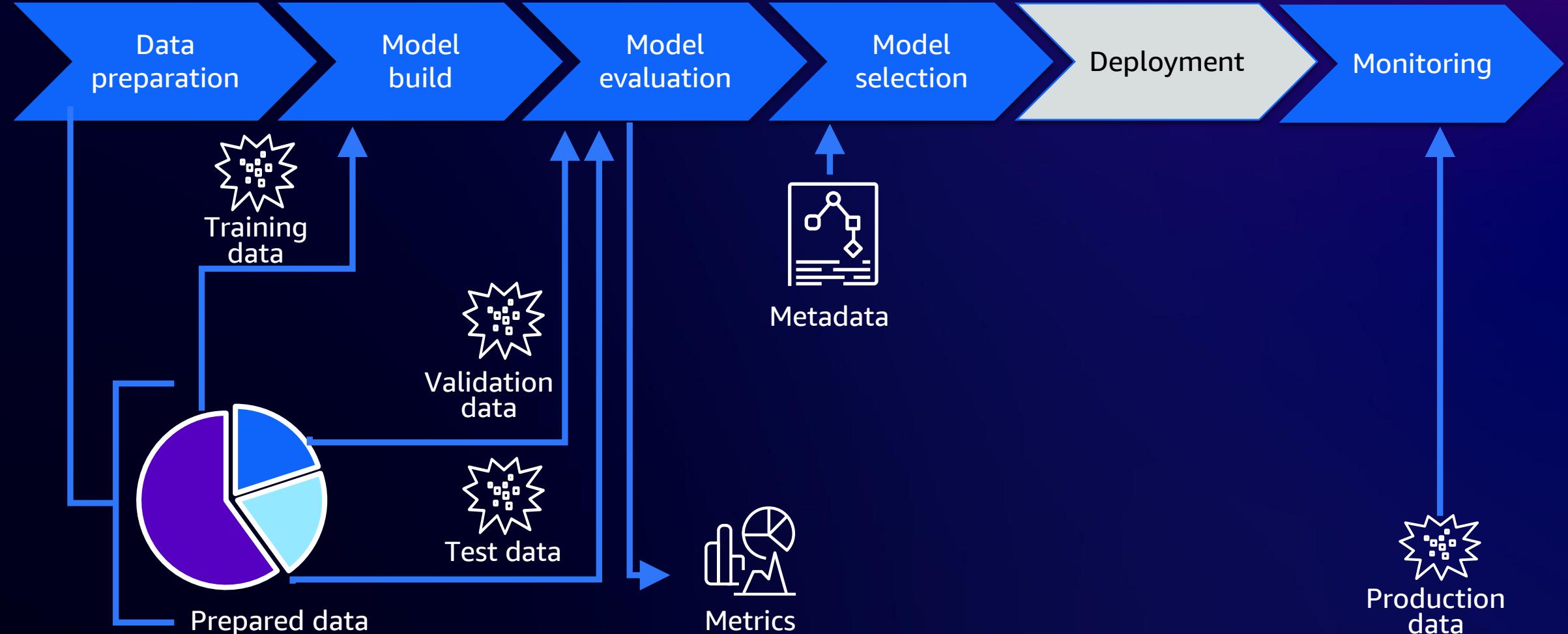
MLOps practices

Data 

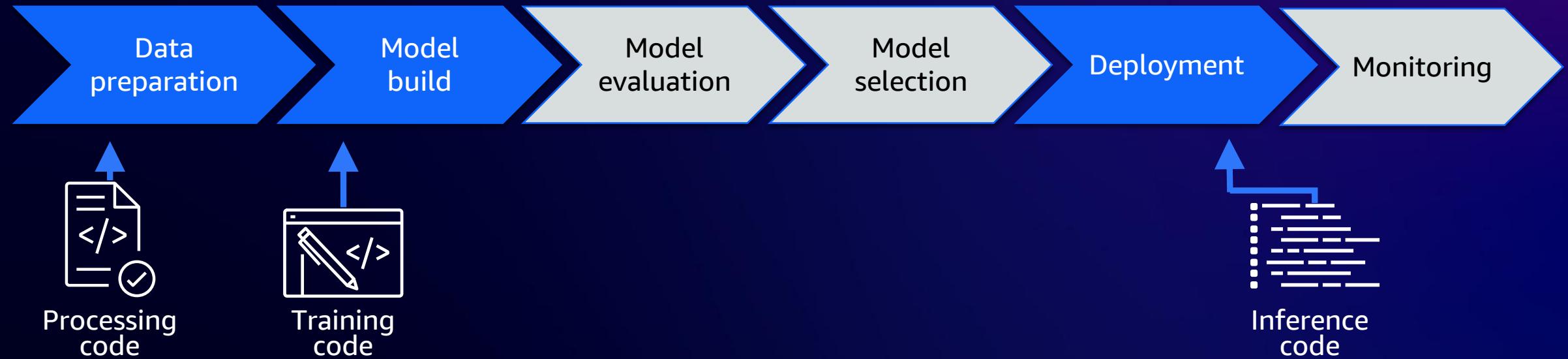
Code 

Model 

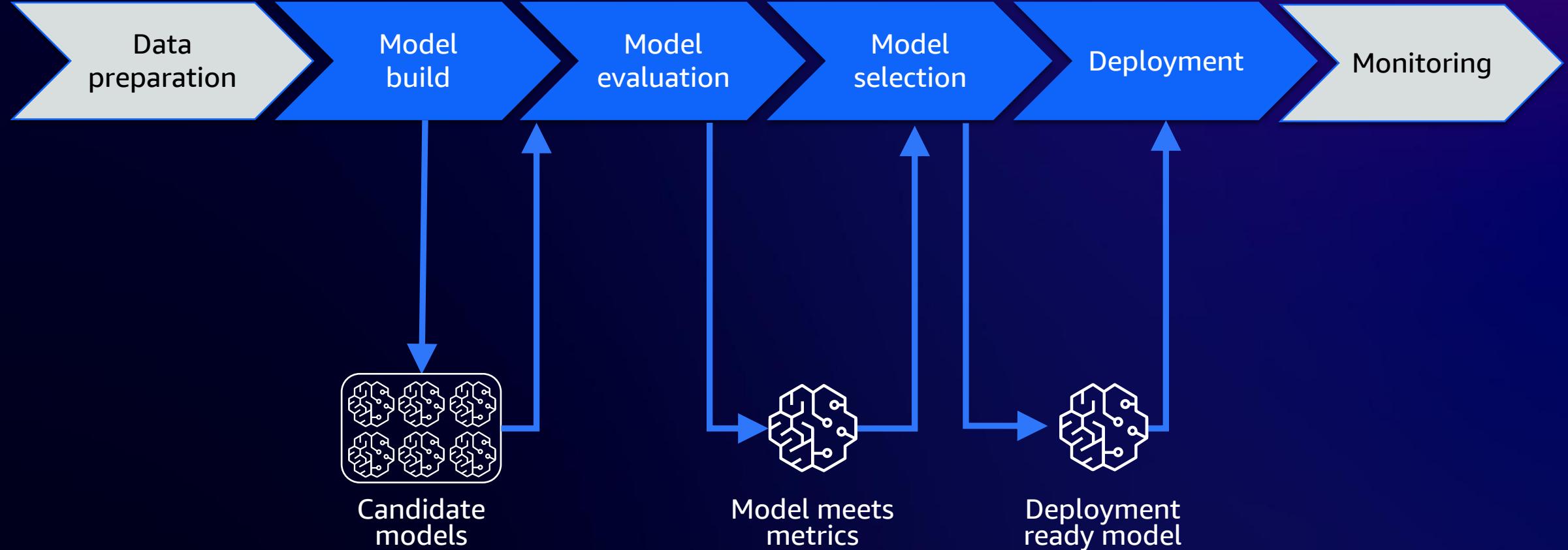
Managing data through the ML workflow



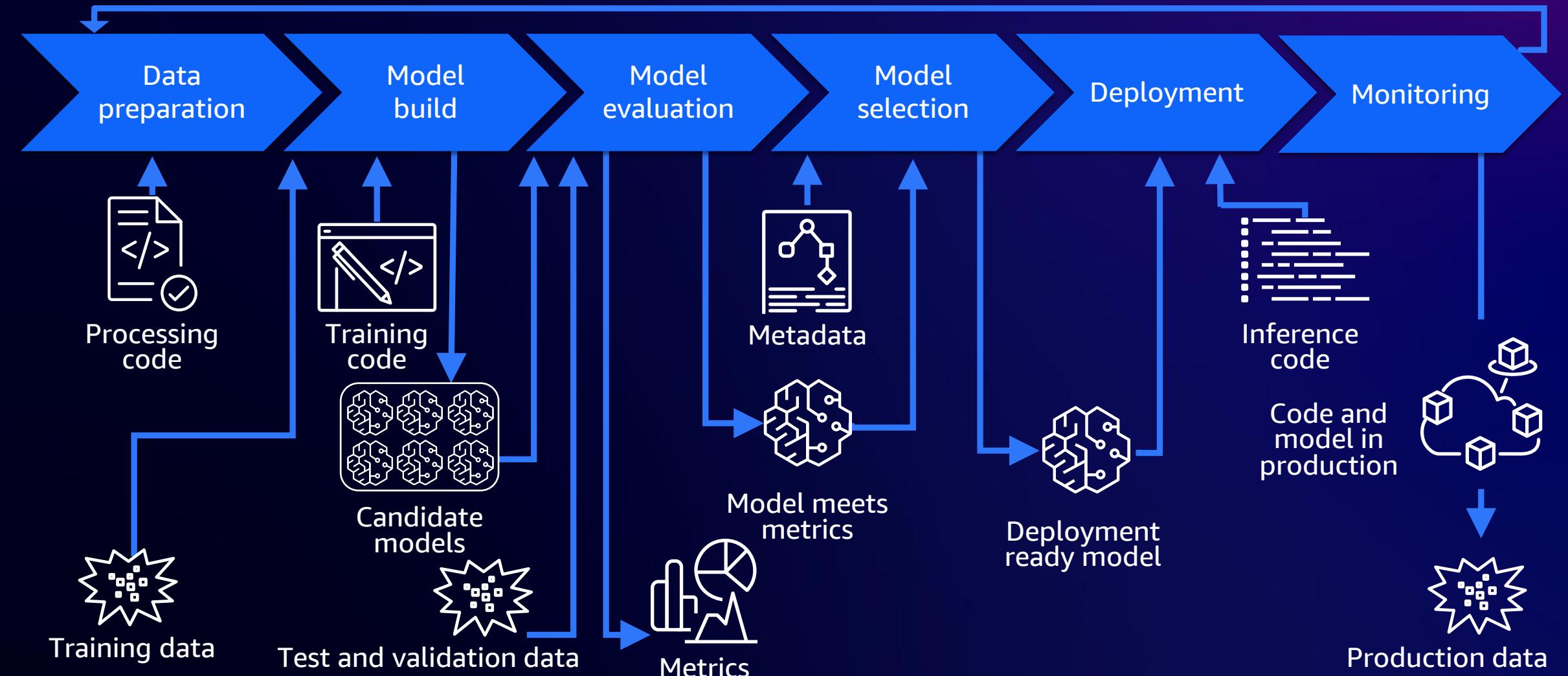
Managing code in the ML workflow



Managing the model through the ML workflow



ML workflow



Applying DevOps concepts to MLOps

Table comparing features between DevOps and MLOps

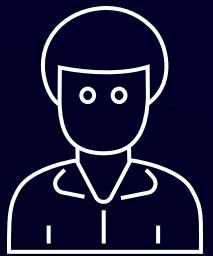
Feature	DevOps	MLOps
Code versioning	✓	✓
Compute environment	✓	✓
Continuous integration and continuous delivery (CI/CD)	✓	✓
Monitoring in production	✓	✓
Data provenance		✓
Datasets		✓
Models		✓
Model building workflows		✓
Model deployment workflows		✓

People

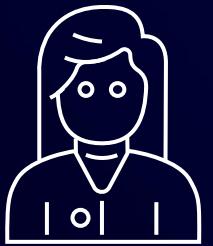
- Topic A: Processes
- Topic B: People
- Topic C: Technology
- Topic D: Security and governance
- Topic E: MLOps maturity model



Typical organizational roles



DevOps
engineer



Data
engineer



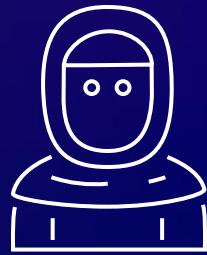
Data
scientist



MLOps
engineer

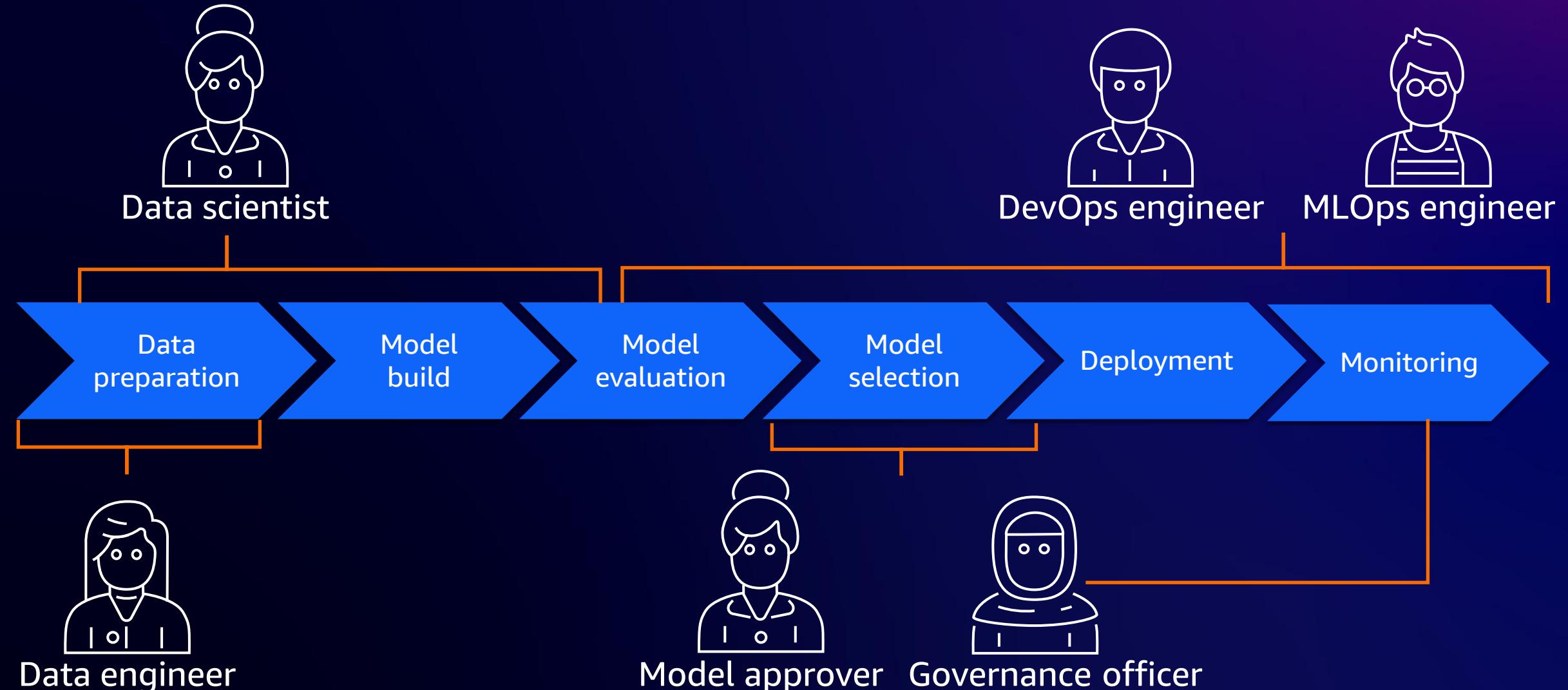


Governance
officer

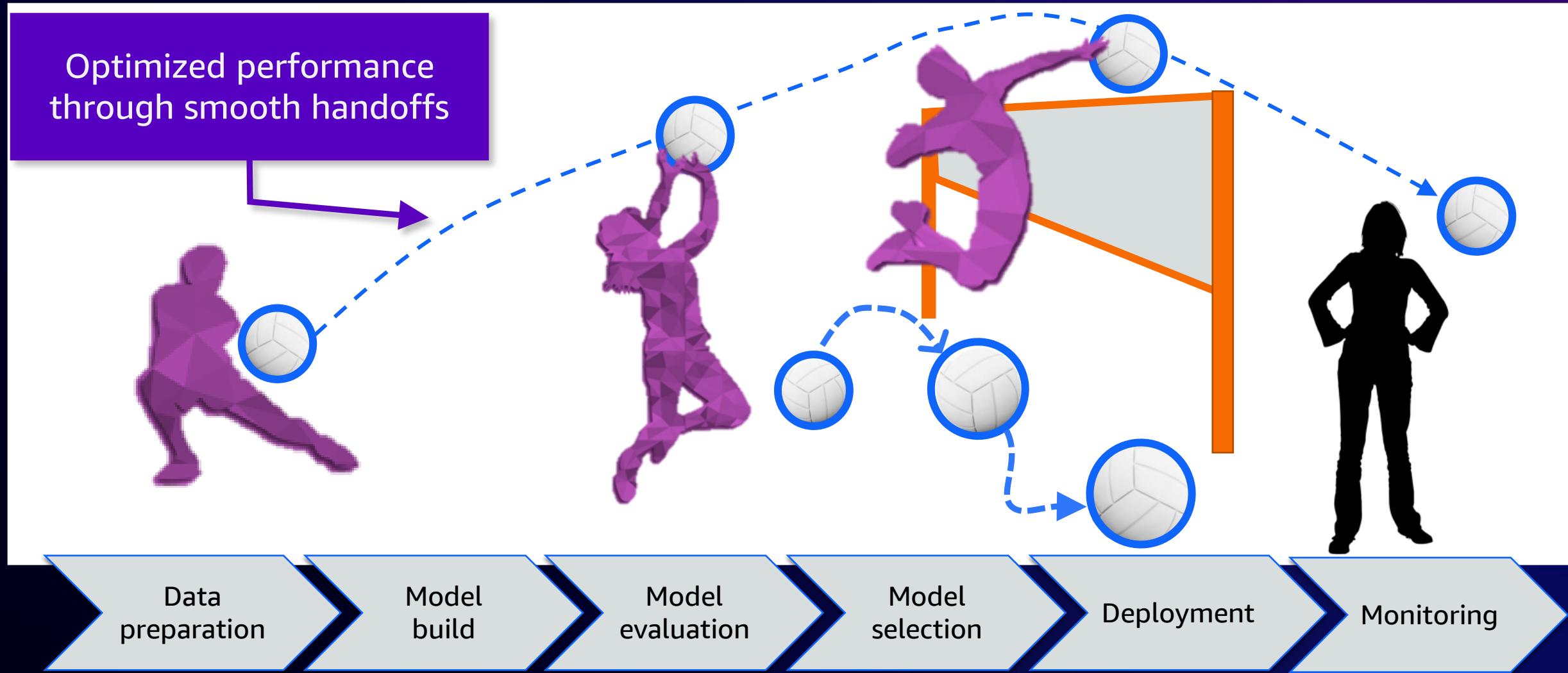


Model
approver

ML workflow and associated roles



Communication considerations for ML success



Your ML team



Where are you on the ML team?

Lifecycle

- Business
- Data
- Develop
- Deploy
- Monitor

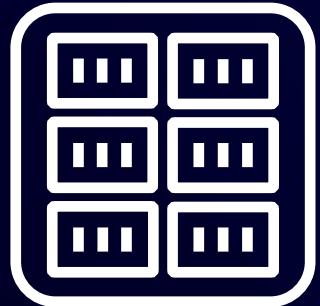
Roles

- Business analyst
- Data engineer
- Data scientist
- ML engineer
- DevOps engineer
- MLOps engineer
- Software engineer
- Governance office
- Model approver
- Security engineer

Technology

- Topic A: Processes
- Topic B: People
- • Topic C: Technology
- Topic D: Security and governance
- Topic E: MLOps maturity model

Implementation considerations for ML



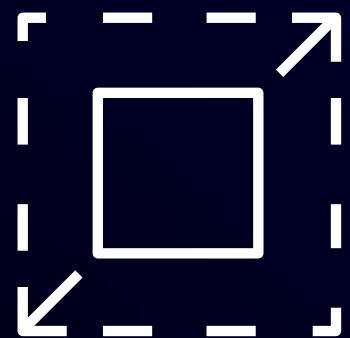
Consistency



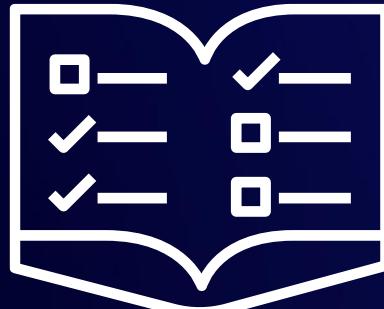
Flexibility



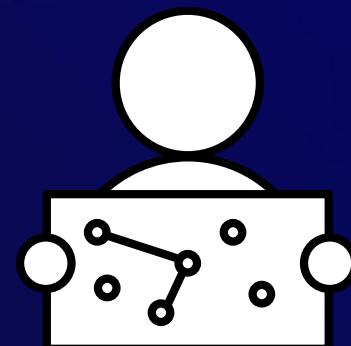
Reproducibility



Scalability

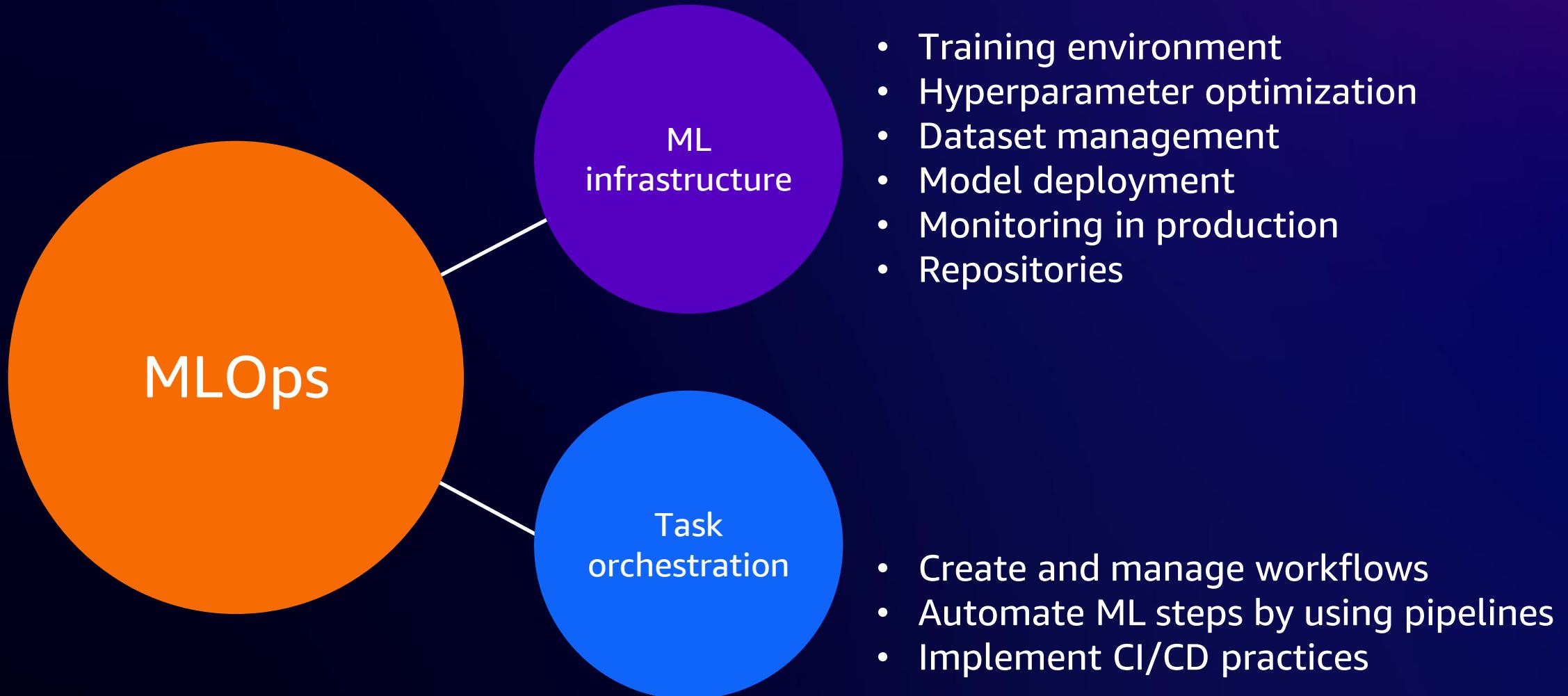


Auditability



Explainability

MLOps technology components



ML infrastructure: Tool selection

Use a managed service



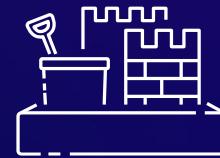
Amazon SageMaker



Fully managed infrastructure, tools, and workflows



Train

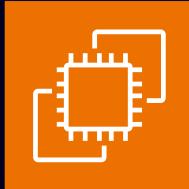


Build



Deploy

Build your own



Amazon EC2



Amazon ECS



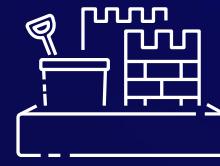
Amazon EKS

Custom solution options on AWS

Customer-managed infrastructure, tools, and workflows



Train

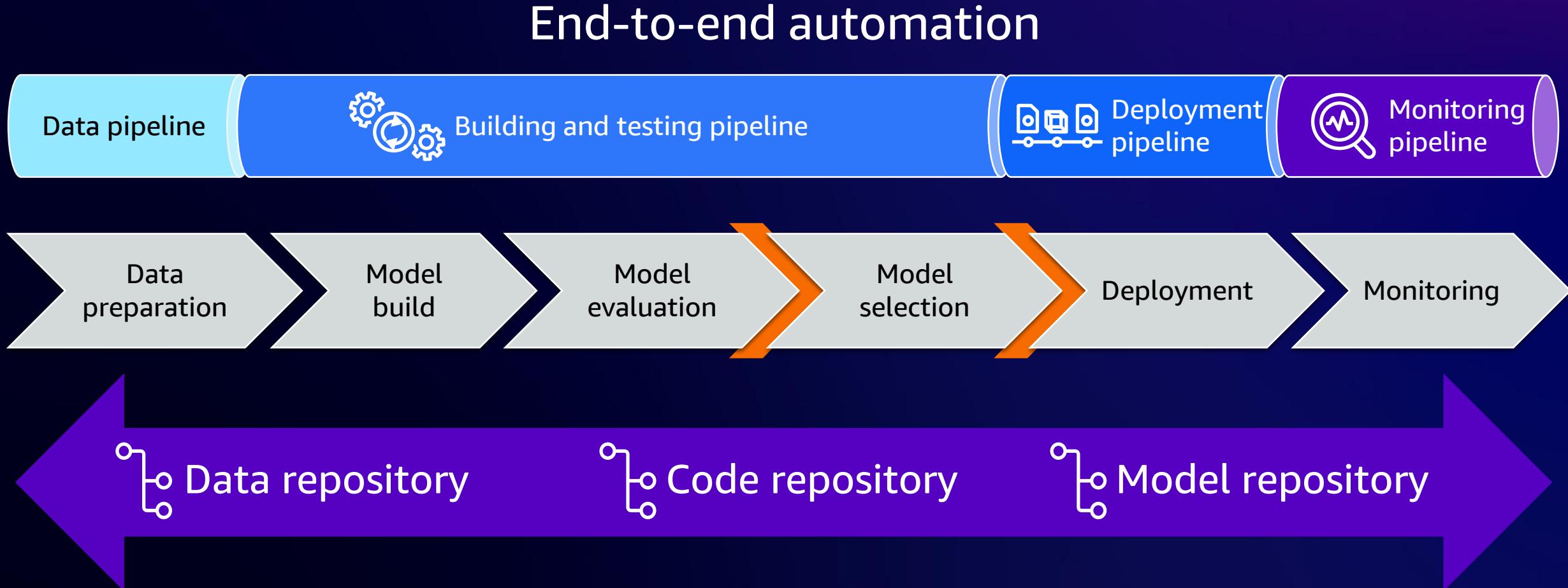


Build

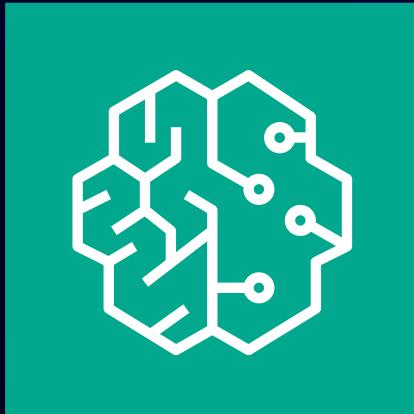


Deploy

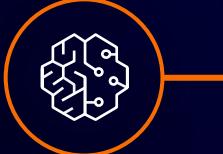
MLOps practices and the ML workflow



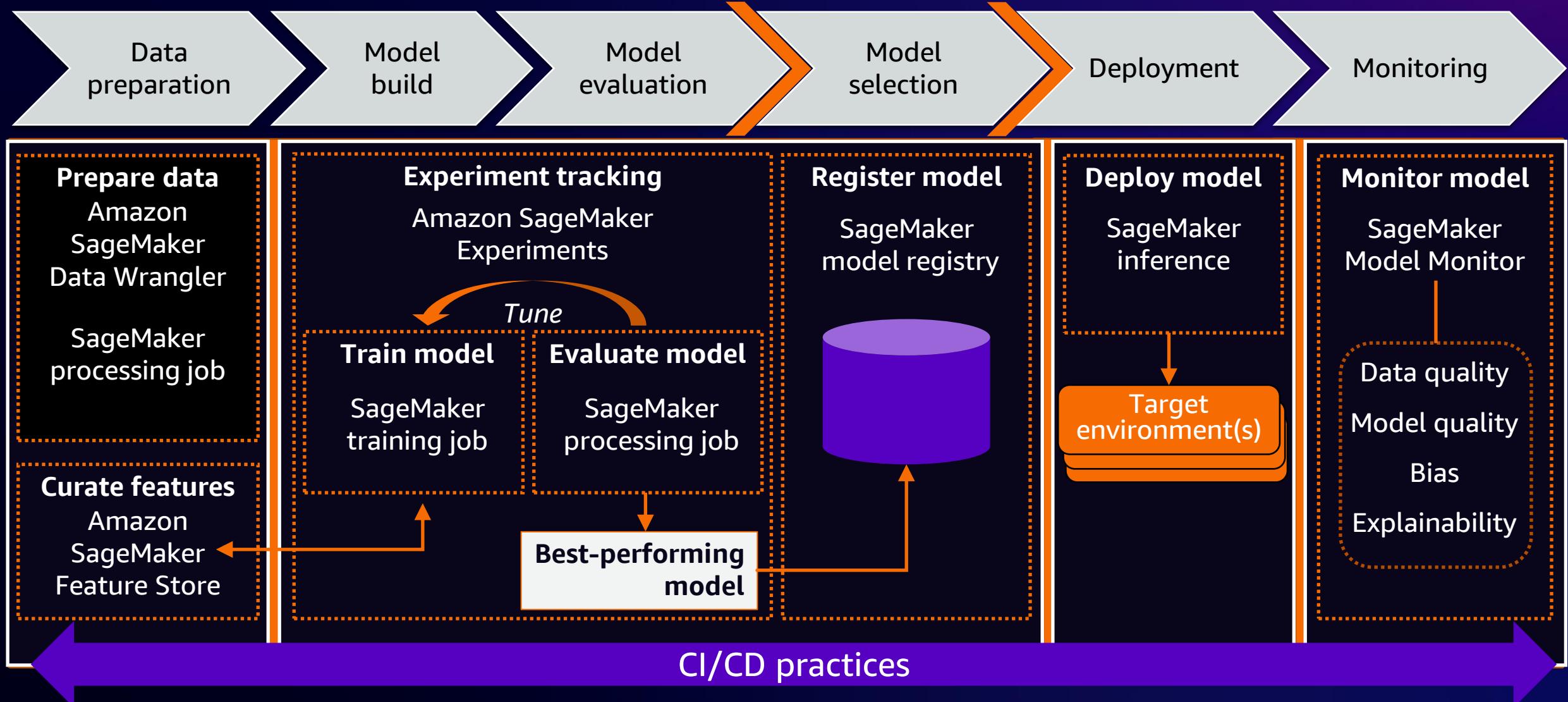
Streamline MLOps with SageMaker



Amazon SageMaker

-  **Automate ML workflows to scale model development**
-  **Build CI/CD pipelines for ML to accelerate model deployment**
-  **Catalog model versions, metadata, metrics, and approvals for traceability and reusability**
-  **Track lineage for troubleshooting and compliance**
-  **Maintain accuracy of predictions after models are deployed**

MLOps-ready features of SageMaker



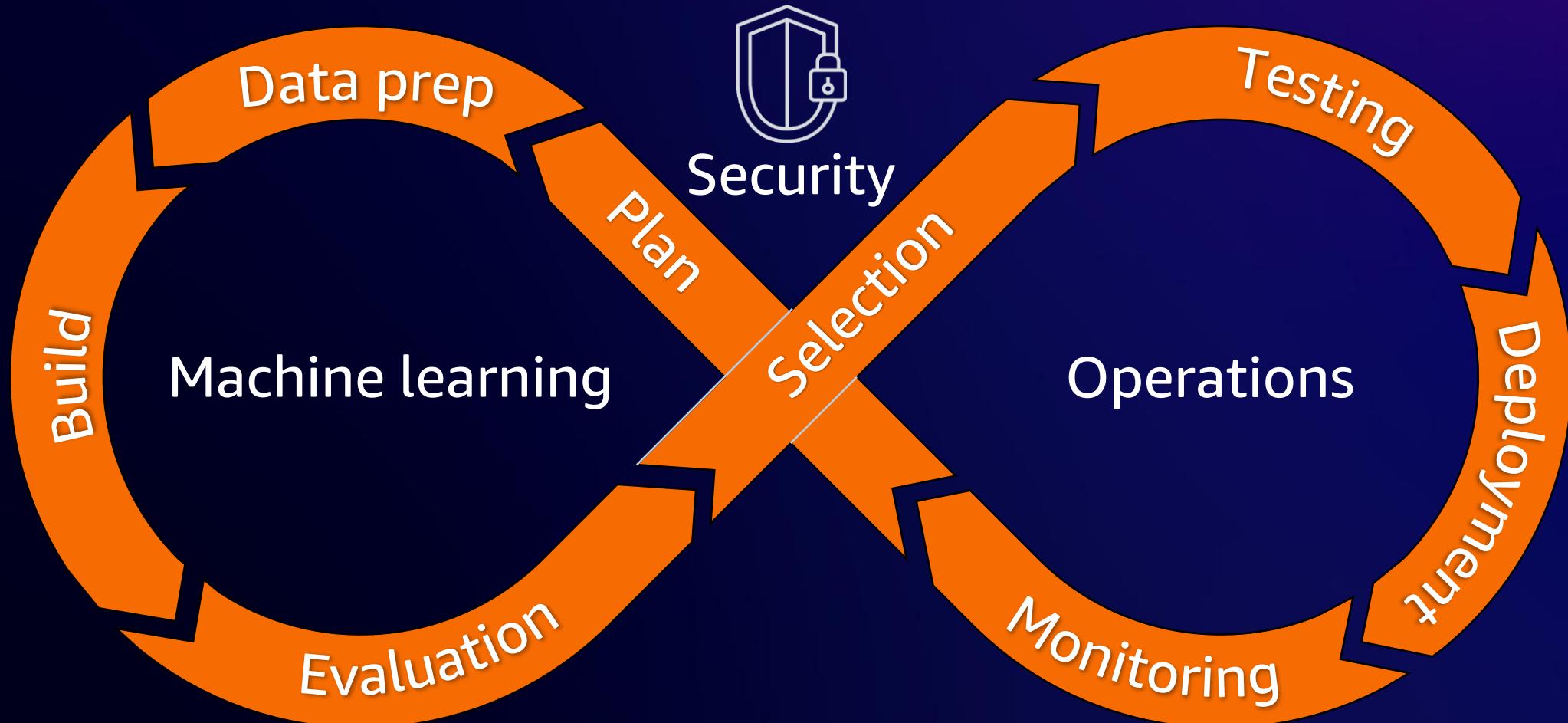
Security and governance

- Topic A: Processes
- Topic B: People
- Topic C: Technology
- Topic D: Security and governance
- Topic E: MLOps maturity model



MLSecOps

MLOps approach = People + Processes + Technology



MLOps security considerations



Network security



Code and container security



Model security



Data security



Security with SageMaker



Built-in
security

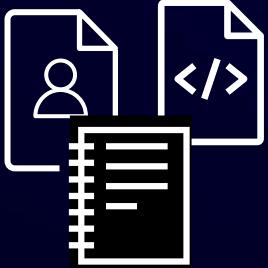
-  **Infrastructure and network isolation**
-  **Authentication and authorization**
-  **Data protection**
-  **Auditability and monitoring**
-  **Compliance certifications**

ML governance



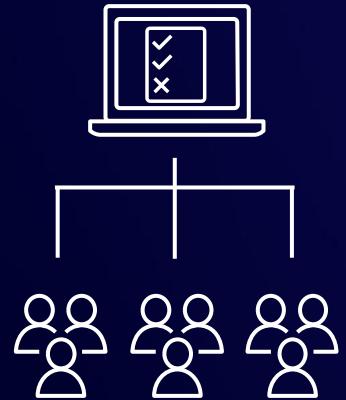
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Governance for ML



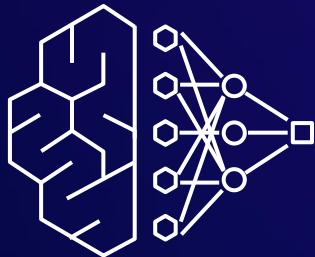
Types of activities

- Create documentation and processes
- Capture business metrics



User groups

- Multiple personas
- Permission management



ML models

- Monitor model behavior
- Detect performance issues



Transparency

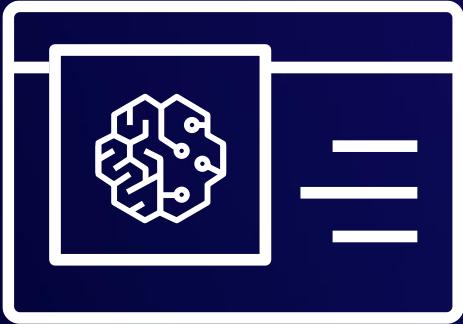
- Auditability
- Compliance with regulations

Governance with SageMaker



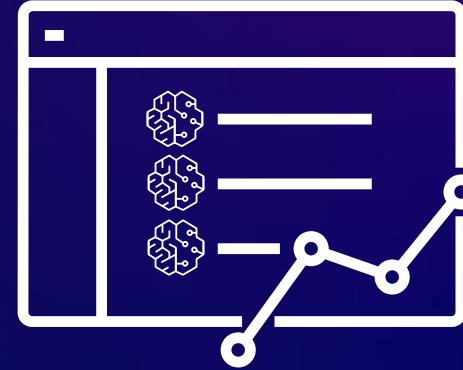
Role Manager

- Simplify permissions for ML activities
- Provide guided workflows for role creation
- Accelerate user onboarding



Model Cards

- Standardize model documentation
- Auto-populate model information
- Share with other parties in a convenient way



Model Dashboard

- Monitor all deployed models in one place
- Receive built-in notifications
- Troubleshoot model performance

Reflection

ML governance in your organization

What is the cost of not implementing ML governance in your organization?



MLOps maturity model

- Topic A: Processes
- Topic B: People
- Topic C: Technology
- Topic D: Security and governance
- Topic E: MLOps maturity model



Understanding MLOps maturity levels

Scalable

Multiple ML solutions



Reliable

Automated testing
Monitoring

Multiple accounts



Repeatable

Standard repositories

Automated deployments



Initial

Secure experimentation



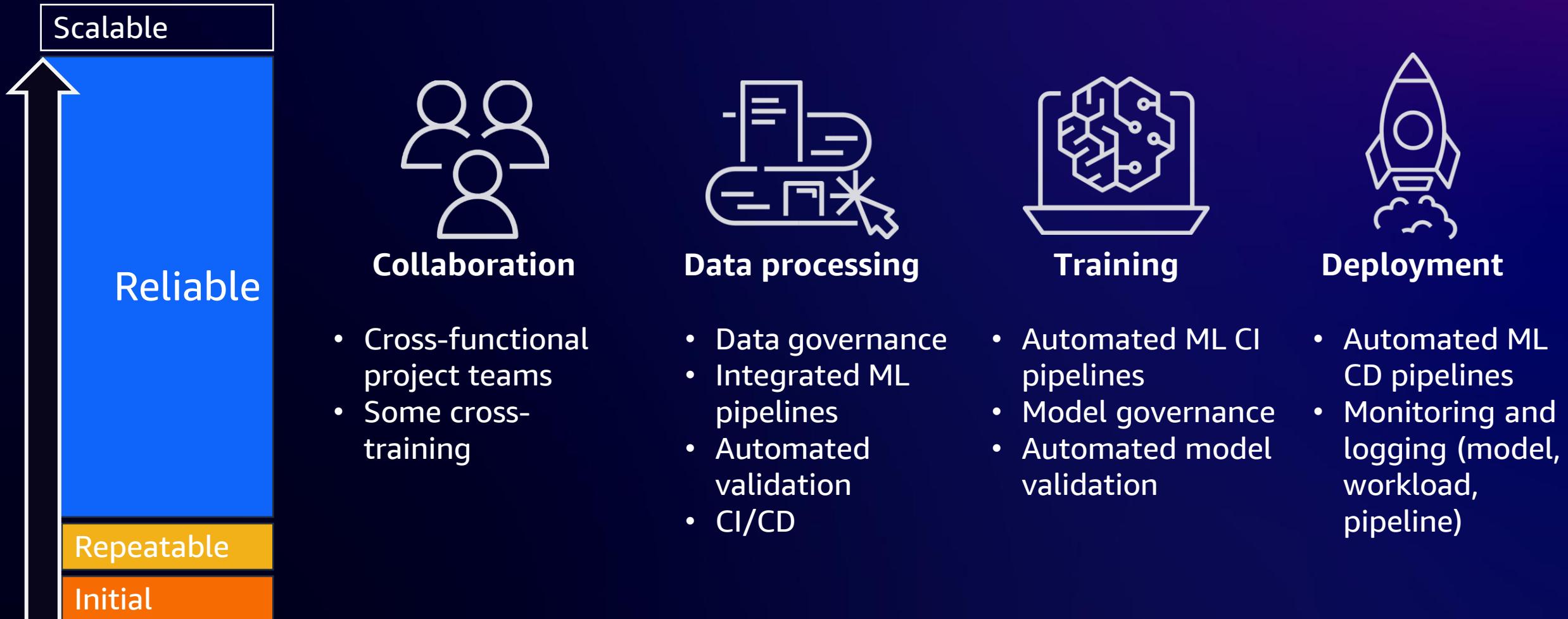
Initial MLOps maturity level



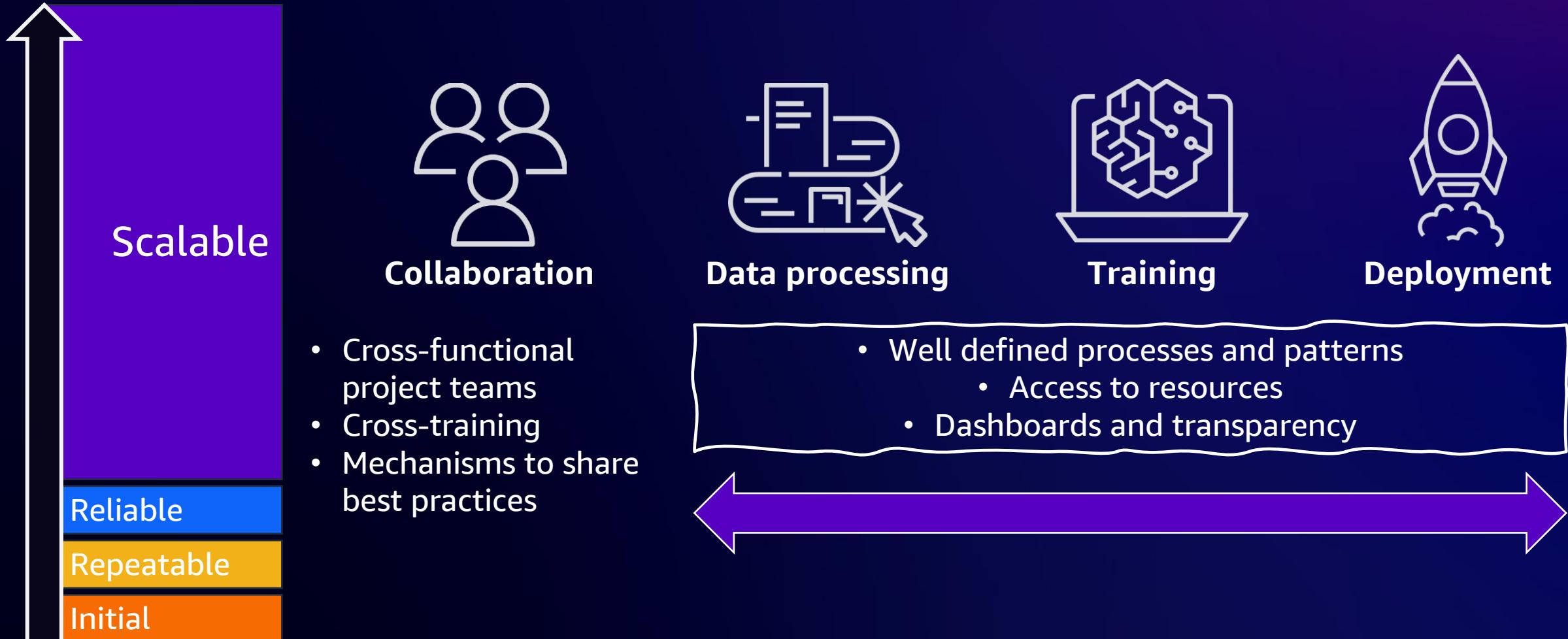
Repeatable MLOps maturity level



Reliable MLOps maturity level

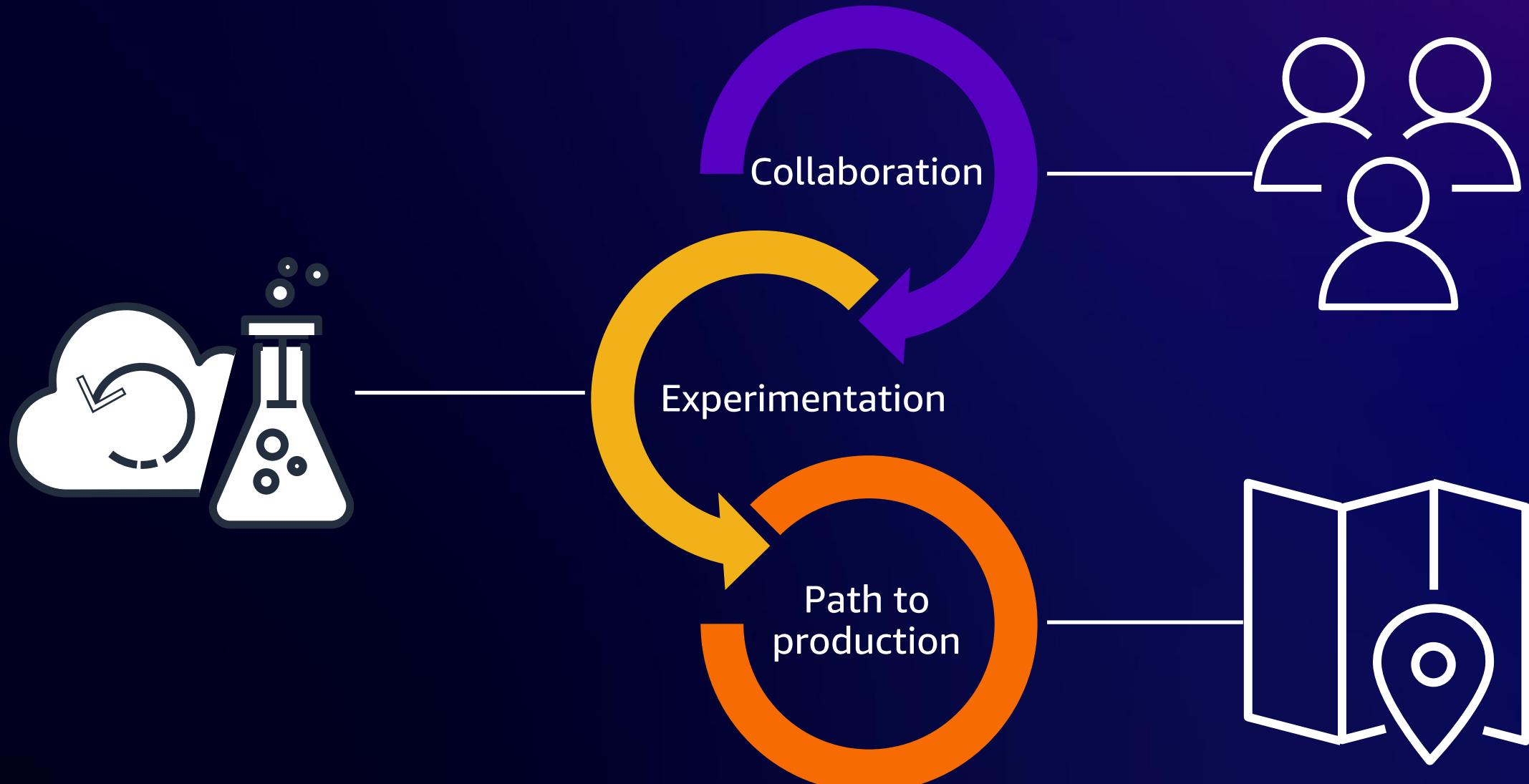


Scalable MLOps maturity level



Key takeaways

MLOps as a journey



Adopt MLOps practices with SageMaker



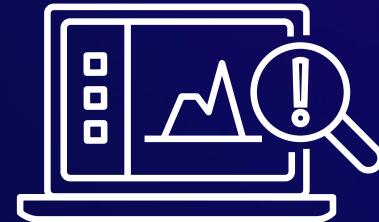
Use purpose-built tools and built-in integrations



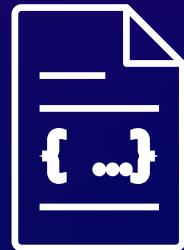
Build CI/CD pipelines



Automate ML workflows



Monitor quality of ML models



Track lineage automatically

Starting your MLOps journey



Documentation

AWS ML whitepapers and guides

<https://aws.amazon.com/whitepapers>



Classroom
training

MLOps Engineering on AWS instructor-led training

<https://aws.amazon.com/training/classroom/mlops-engineering-on-aws>



MLOps tools

MLOps Workload Orchestrator

<https://aws.amazon.com/solutions/implementations/mlops-workload-orchestrator>



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Q&A



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